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**Computer Network Security
and
Directory Services Architecture**

**Final Report
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FORWARD

The University of Alabama in Huntsville appreciates the opportunity to support the development and expansion of the local area network (LAN) for the U.S Army's Software Engineering Directorate (SED). Our involvement in the earlier development of the LAN provides us with a unique insight into the SED LAN and its users. The team assembled to work on this effort was thus able to provide a historical perspective on technology growth that few others could have.

Part of the analysis of a computer network like that at SED involves planning for long term use. This includes planning for new equipment, growth in services, and smooth transitions to new technologies. Planning for new technologies involves ensuring that they can be migrated from the center of the network (high-speed communication between parts of the network) to end user technology (connection to the desktop) as the core of the network is upgraded over time. This process is not unlike the strategy auto manufacturers use, adding a new top of the line model every few years, dropping the lowest end model at the same time. Our recommendations for high-speed networking stem from an analysis of the long-term growth potential of new technologies and the (in) appropriateness of upgrading end user connectivity in the short term.

SED Network Support Team

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1.0 INTRODUCTION

This is the final report for Delivery Order (D.O.) 9, "F/DOD/ARMY/AMCOM/Computer Network Security and Directory Services Architecture." As such, it represents the collective effort of six UAH employees, together called the 'SED Support Center Team,' or simply the 'Support Center', over the course of ten months.

This report details the activities related to the various tasks in the D.O. and is arranged by task within section 2. Section 3 summarizes the activities and recommendations of the Support Center. A list of items purchased on this D.O. is included in appendix A.

2.0 ACTIVITY REPORTS

The following sections cover the various tasks in the D.O. The relevant activities for each item are summarized within the appropriate section. Each section opens with the text from the Statement of Work (SOW), detailing the requirements for that particular area of effort; this provides the context for the activities performed.

2.1 Directory Service Synchronization

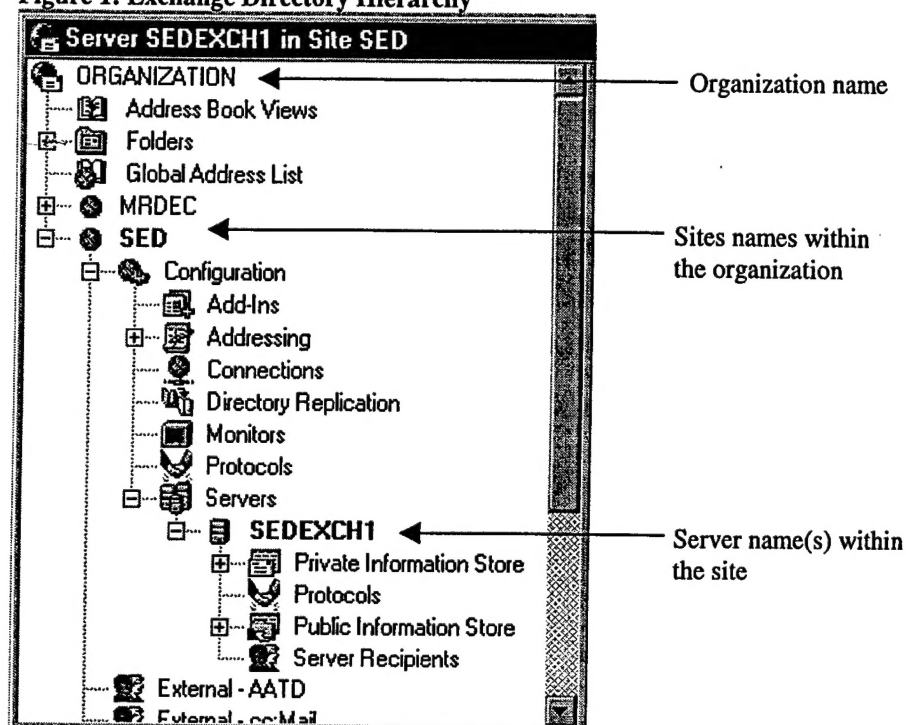
Research architectural and equipment issues related to the implementation of a synchronized directory service. Consideration shall be given to the current Email structure, the Directorate database, the impact of Defense Messaging System (DMS) compliance, and the use of X.500 directory services. Implement and test candidate solutions.

The task of synchronizing email directories has become a priority both here at the SED and on the Redstone Arsenal as a whole. The Command Group has been pushing for a unified email directory system, and has mandated that all the email servers on the Arsenal migrate to Microsoft Exchange. In addition, many SED users have asked for visibility to the email directory for the entire Redstone Arsenal. But while having an Arsenal-wide directory is a clear advantage to the user, for the system administrator it can be very difficult. Directory information changes on a daily basis for an organization the size of the Redstone Arsenal. Keeping all the directories up to date is monumental task, especially when so many different email systems and servers are being employed. During this delivery order the SED network support group studied and implemented a number of directory services for our users. The SED Exchange server was also readied for integration with the Redstone Arsenal servers.

The Exchange Move Server Wizard

The Exchange Move Server Wizard is a key component in directory synchronization efforts involving the Microsoft Exchange email system. When Microsoft Exchange is initially installed on a server, the administrator must specify the organization and site name for the system. These names are used to describe a hierarchy of Exchange servers. For years after Exchange Server was first published, there was no way to change the organization and site names once they had been set. The only method for alternative was to completely remove and reinstall the Exchange server with the new org. and site name. All data on the old server would be removed along with the server, and putting it back in place after the server was reloaded was very difficult. Since then, Microsoft published the "Exchange Move Server Wizard." This program allows existing Exchange servers to change organizations or sites with minimal impact to the users. Even this tool has its problems however.

Figure 1: Exchange Directory Hierarchy



Problems with the Move Server Wizard

The Exchange server organization and site names were not designed with change in mind. To change the server name – even with the correct tools – requires a good deal of work on the part of the system operators, and damages parts of both the server and the client in the process. For example:

- 1) Most of the personal address books of the client machines break and cannot be repaired. The broken address book entries have to be deleted and recreated.
- 2) Any server-side mail routing rules break and cannot be repaired. Like the address book entries, they must be deleted and recreated. In addition, the newly created rules cannot be modified after they have been created.
- 3) All public folders and mail connectors must be removed from the server before the move, and recreated afterwards. The contents of these folders must be stored elsewhere while the move is proceeding. Also, the permissions on each folder and settings for each connector must be written down so that they can be restored when the items are recreated.
- 4) The move server wizard rewrites all the X.400 and X.500 email addresses in the organization and if the server name has changed, all the SMTP addresses as well. The rewriting rules are rudimentary and cannot be adjusted by the user. The result is that in many cases the email addresses for the entire organization must be reworked by hand after the move is complete.

This begs the question, "Why would anyone want to move an Exchange Server?" The reason is connectivity. Only when two Exchange servers are in the same organization can they connect with each other using a "site connector," also known as an "Exchange connector." The site connector is the fastest, most reliable email transfer method available to Exchange server. Not only does it transport email messages, it also shares directory information between servers so that they function as one logical unit. It is often worth the difficulty of moving a server to achieve the connectivity of the Exchange site connector. Also, using the move server wizard is still much more efficient than reinstalling Exchange.

The Exchange X.400 Connector

The Exchange X.400 connector comes with the Enterprise version of Exchange, and offers a second connectivity option outside of the Exchange site connector. The X.400 connector has many of the same advantages as the Exchange connector. It provides a direct path for email between two servers, and can synchronize the directory information between two or more servers. Messages sent and received using an X.400 connector must be converted to X.400 format and back, making the connector somewhat less efficient than the Exchange connector. The advantage of the X.400 connector is that it can connect the Exchange system to other non-Exchange email systems that also use X.400.

Problems with the X.400 connector

The network support team tested the X.400 connector looking for possible alternatives to the Exchange connector. It was feared that the Exchange connector would give control of the entire organizational directory structure to all servers within the organization. Since the different servers in the organization are managed by different groups of administrators, this could cause problems. The X.400 connector, it was thought, would reduce the possibility of system administrators of different systems creating problems on the servers that were not their own. During the course of testing however, this assumption proved false. While it is true that only a very limited amount of administrative access is allowed across the Exchange X.400 connector, apparently what access there is, is flawed and can cause serious problems. Furthermore, it was discovered that the regular Exchange site connector could be implemented with administrative access controls that prevent administrators of remote systems from changing the local one.

The LDAP Extension for Outlook

Some of the users at the SED had an immediate need for directory access to other email systems on the Redstone Arsenal. Since moving a server takes so much time and effort, these users needed a stop-gap solution for directory access. The Microsoft LDAP directory connector offered them just what they needed.

LDAP is an acronym for "Lightweight Directory Access Protocol." It is an open standard, and thus provides simple way for servers to share directory information with non-proprietary clients. The Microsoft Exchange Internet mail connector provides LDAP services by default, even though the Exchange and Outlook clients cannot access this information. However, Microsoft has written an LDAP extension for Outlook that allows it to read LDAP directories. The extension installs as a service, and integrates with the regular address book features of Outlook.

Problems with the LDAP Extension

The only problem with the LDAP extension for Outlook was its awkwardness for the users. Although the extension integrates with the Outlook address book, it does not give the user direct visibility to the addresses of the server it points to. Instead, when a user selects the LDAP connector he or she sees a blank address book and must perform a search to find any information. This is counter-intuitive for most users. It also means that it is very difficult to find certain kinds of information in the directory.

Moving the Server

At the beginning of this delivery order, the Exchange server at the SED was running on a machine named "Susie", a quad-processor Alpha Server 2100. The organization name for this installation was "SED" and the site name was "Building 6260". Under the new regulations¹ passed down to us by the AMCOM commander, this naming convention had to be changed. The new organization name would have to be "ORGANIZATION". The machine name and site name would also have to be changed. New hardware (an Alpha Server 4100) had been purchased to host the SED Exchange server so the decision was made to change all the directory names as the transition to the new hardware took place.

Preparations for the server move

To prepare for the move to the new server, the new server hardware was set up and tested. The operating system (Windows NT 4.0) and Microsoft Exchange 5.5 had to be installed on the new hardware platform, along with the latest service packs for each and the "Move Server Wizard" for Exchange. Also, the tape backup system on the new machine had to be installed, configured, and tested. The Exchange system was set up under the old "SED" organization and connected to the existing Exchange server "SUSIE". The new server was christened "SEDEXCH1". The connection between SEDEXCH1 and SUSIE would later allow all the account information and stored mail from SUSIE to be moved to SEDEXCH1 automatically.

Test accounts were created on SEDEXCH1 to verify that delivery of mail would be uninterrupted when the actual mass migration was performed. After preliminary testing was complete, several of the active Network Support accounts were moved to the new server. The network support team used the server for several weeks to test its reliability. It was discovered that when an account was moved to the new server, several small changes had to be made on the client side to enable the user to continue receiving mail. These changes would have to be made on every single client machine at the SED – over 400 machines at the time. Since the SED does not have any kind of end-node management software installed on the clients, the changes would have to be made by hand. However, the changes were simple enough that the average user could make them if properly instructed. As a result, a web page was written explaining how to update a client machine to receive mail from the new server.

¹ AMCOM regulation number 25-15, "Information Management – Management, Protection and Use of Federal Communications Resources."

A week before the migration, an email was sent to all the Exchange users explaining the server migration and referring them to the web site. The same email was sent again, as a reminder, on the day before the migration began.

The server migration itself was done over a weekend. The following tasks were performed:

- 1) A full backup of the entire email system was made, including both the system and data disks. Backups were verified for accuracy.
- 2) All the users from the old Exchange system were re-homed to the new Exchange server. This automatically moved all their email to the new server.
- 3) The settings for the Internet mail connector, and all public folders were recorded on paper so they could be restored after the move.
- 4) The contents of each public folders were temporarily stored in a personal storage file (a ".pst" file) so they could be restored after the move.
- 5) The Internet Mail Connector and all public folders were deleted.
- 6) The connection between the two email servers was severed, and the old mail server was powered off.
- 7) The Move Server Wizard was run on the new email server, and the new organization name ("ORGANIZATION") and site name ("SED") were set.
- 8) The Internet mail connector was re-installed on the new server, and reconfigured.
- 9) All the public folders were re-created, and their settings and contents were restored.

Results of the server move

The server move was time consuming, but went relatively smoothly. The most time consuming part was dealing with the public folder contents and security settings. In spite of the advanced warning that the SED user community received, many of them still forgot that the server move was scheduled to occur and called the helpdesk on Monday morning after the move. Others had problems following the update instructions on the web page. Fortunately however, the majority of the SED users were able to update their own clients, as was hoped. Several small, unanticipated problems arose after the migration:

- 1) Some users who connected to the server over a dial-up connection had problems with their offline store (.OST) file. The .OST problem only occurred on machines which were (1) configured to access the Exchange server directly (i.e., using the "Microsoft Exchange Server" service, not the

Internet mail service) and (2) accessing the Exchange server using "remote mail" via a dial-in connection.

- 2) A number of the users on the old email system had been giving people their server-specific address, "username@susie.sed.redstone.army.mil" When they were moved to the new server, they could no longer receive mail at this address. The problem was dealt with simply by informing the users and through them, their contacts of the correct email address.

Current Implementation

Currently, the new email server is currently in full-time production. The system has almost 500 users, and does not show any sign of overloading or bandwidth problems. The user community is pleased with the service they are receiving, almost without exception. The problem now is the politics between organizations on the Redstone Arsenal. The server was originally moved to the org. name "organization" so that it would comply with the naming conventions passed down to us by AMCOM, and so that we could establish a connector between our server and the one at Redstone's Corporate Information Center (CIC). Before the server move began, it was understood that this would not be a problem. However, by the time the server move was complete, the policy had changed, and currently no one is allowed to connect to the CIC email servers. Even so, the server move has not been a waste of time. The new server is faster than the old one, and the new organization name is still mandated by the AMCOM policy. It is unfortunate that the directory synchronization will have to be done without the MS Exchange connection, however. An Exchange connection is being negotiated with AMRDEC, the parent organization to the SED. It is hoped that AMRDEC will be able to get a connection to CIC before long, so that the Redstone directories can be synchronized through them.

2.2 Web-based Directory Services

Research architectural and security issues related to adding directory services access via World Wide Web (WWW) browsers to existing WWW architecture. An architectural security model shall be developed to address provisions for controlling access to some information while making other information publicly available. Implement and test candidate solutions.

There are two directories maintained at the SED. One is the employee/telephone directory; the other is the email directory. The employee directory is kept in an Oracle database, while the email directory is (of course) kept in on the email server, in it's own database. By default, neither one of these databases is internet-accessible, or viewable with a web browser. But web-based accessibility has become important to so many people that database software companies have made web accessibility much easier to achieve. This is true of both of the database systems mentioned above. Microsoft has provided a web-mail interface for Exchange server that allows users not only to view email directory information, but also to send and receive email, and use other Exchange services. The Oracle Corp. also provides well-developed tools for publishing database information on the Inter- or intranet. The task of the network support group is to implement the web publishing systems and the

security systems to insure that only authorized people will have access to the published information.

The administrator who manages the Oracle database at the SED is not part of the regular network support group. Because of this, most of the responsibility for implementing the web interface for the SED telephone directory has fallen outside the team. As a result, the Network Support Team primarily deals with three different areas in web directory publishing: Synchronizing the information in the two SED databases and the other Redstone email system, publishing the email system directory for the SED users, and securing both systems against possible misuse.

Initial Conditions

The initial implementation of web-mail occurred before this delivery order, but it was not made available on a production scale because it was not secure. Although usernames and passwords are required before a web-mail user can access any sensitive information, the default web interface does not encrypt the login authentication process. As a result, someone with a network protocol analyzer could have easily discovered the authentication information for our customers who use web-mail. As a result, the initial implementation of web-mail was limited (with IP address filters) to use by people within the SED LAN. Of course, this made the web-mail implementation almost useless since everyone on the SED LAN had better email clients than were offered through the web interface. However, it did give the network team a good opportunity to test and tune the system, and it provided an additional access method for users who dialed directly into the SED network with a modem.

Background

During this delivery order, software was installed on the SED Exchange server to allow it to offer encrypted web pages using SSL. The SSL software used comes with the Microsoft Internet Information Server and Management Console. In order to use SSL on a web server, the server must be registered with a certificate server. The certificate server provides the web server with a source of authority, so that clients can verify the identity of the server, and trust the content received from the server. To initiate the connection, the web server must send a key request to the certificate server. This key is generated by the system administrator, and sent to the administrator of the certificate server. After the web server's identity is confirmed, a certificate is returned to the web server. The certificate is a digitally signed document containing the certificate server's public key and certain connection parameters. The certificate is stored on the web server by the administrator and configured to operate with specific network services. This allows the web server to prove its identity to any client that connects to these services.

When a client connects to a web server running SSL, it negotiates the connection, verifies the identity of the server it has connected to, and then establishes a symmetric cryptographic key that will be used to encrypt whatever data the client sends or receives. Using SSL on the SED web mail server strengthens the security of our web mail system in several ways:

1. **Privacy.** The 128-bit encryption used on the SED server provides a reasonable level of privacy. This is especially important because users

submit passwords across the network in order to log onto the email system. Also, the email messages and directory data sent to the client contain sensitive information that must be protected.

2. **Authentication and data integrity.** SSL provides a way for the client to verify that the server is actually the machine it claims to be, and that the data it sends has not been tampered with. This is important on the Internet, since it is not difficult to set up one computer to masquerade as another.

Implementation The following steps were taken to install SSL on the SED web mail server:

1. Install the current version of web mail. This was done concurrently with the server move. Patches and updates also had to be installed.
2. Request an SSL certificate from the approved authority for government web servers.
3. After receiving the certificate, install it on the SED web mail server, and configure it to run on the proper ports and web pages.
4. Modify the web mail pages so that the SSL session will be established before the login authentication takes place
5. Modify the web server configuration so that (1) web mail could not run unless it was encrypted, and (2) users would automatically be connected to the secure sockets port when they connected to the server.
6. Register the web mail server with Redstone's Corporate Information Center.

After these steps were taken, the web mail system was put into production. In order to minimize the risk of unauthorized access to the system, all users accounts were initially set to deny access to the web mail system. Then, as users requested web mail service, they were allowed in one at a time. This policy remains still in effect.

Today the SED web mail system is an integral part of the network infrastructure. Very few problems were encountered while implementing this system, and it is hoped that it will continue to provide the SED users will remote access to email and directory information for years to come.

2.3 Network Monitoring

Research solutions to provide for computer network monitoring to include error detection/recovery and considering network security vulnerability issues. Implement and test candidate solutions.

Security Regulations on Monitoring

Army Regulation 380-19 specifies what users are allowed to do with Govt. resources, including the Internet. There are numerous products that allow us to monitor this Internet traffic for enforcement. However, there is another group currently running the Redstone Arsenal Campus network that has full monitoring functionality set up over the entire campus. Currently there is no need for us to duplicate this monitoring on the local level. Any incidents that are reported by the campus group are then tracked and handle at the directorate level.

Tools Available

Expansion plans for the SED network include upgrading to Fast Ethernet to the desktop. When this happens there will be no monitoring capability for the Fast Ethernet because none of the current Sniffer products can monitor at Fast Ethernet speed. Newer versions include the capability of monitoring up to Gigabit speeds. As the new network comes online, analysis will be made of current technologies to choose from what is available at the time. Trying to make any decisions at this time is futile due to the volatility of available products.

We are also looking at modules that will integrate into the new network which allow on the fly SNMP and RMON traffic monitoring for analysis. These tools will allow us to redirect all traffic from a specific port to this module and analyze the traffic from there.

Implementation of Tools

ClearVISN, a management utility created by Digital Equipment Corporation, gives the ability to manage all network equipment via a graphical utility from a single workstation. ClearVISN is a policy based network management product that allows SNMP configuration for all DEC hub based products, including switches and VLAN (virtual LAN) management. This also includes firmware upgrades to almost all modules.

We have also installed CiscoWorks 2000, an SNMP Web based products used for management of the Cisco modules on the new network. This product allows for monitoring and configuration management of all Cisco products within our control, greatly simplifying management.

2.4 Operational Network Support

Provide operational computer network systems support. Operational support consists of providing solutions to network problems, collecting information on network status and utilization, testing for network vulnerabilities, and investigating millennium date change (Y2K) impact.

The total number of requests that the Support Center has processed during the period of performance of this Delivery Order is approximately 1600 - 1800. Extrapolating that to one year's time (accounting for an increase in requests over

time) we estimate that over 2000 requests were serviced in a year's time. This number is very significant when you consider the fact that the Support Center does not actively advertised its existence to the SED community. Both the Support Center staff and the Army technical monitor agreed at the beginning of this project that the Support Center was significantly understaffed to handle the support needs of the entire SED community.

A more accurate total number of requests serviced, along with service times and other typical statistics, is difficult to arrive at because every problem handled was not logged. It is recommended that multi-user software be purchased or developed in the near future to provide more detailed problem tracking and reporting abilities.

Examples of service:

- Adding and configuring our IP subnets (now have 1280 internet addresses of which about 1050 are used, increasing at the rate of about 15 per month)
- Resolve address conflicts, notably IP
- Activate and deactivate serial ports in offices
- Add thinnet and/or 10bT ports to offices
- Reroute and extend the building network in the high bay area
- Troubleshoot network connection problems on computers running Windows
- Troubleshoot PC, Mac, Sun, VAX problems, both hardware and software related ("My ... won't work.")
- Manage name server entries
- Assist user with Microsoft Exchange Problems
- Install of network software on various PCs
- Numerous forgotten password problems
- Accommodate on the network personnel and equipment moves within SED
- Plan for expansion of service team and bolstering of support capabilities
- Monitor and protect against virus attacks
- Monitor and
Protect against reported hacker and/or denial-of-service attacks

3.0 SUMMARY

Directory Service Synchronization During this delivery order the SED network support group studied and implemented a number of directory services for our users. The SED Exchange server was also readied for integration with the Redstone Arsenal servers.

Initially, the LDAP connector for Microsoft Outlook provided the user with some global address book features until the server move was complete. Moving the server was a delicate task, but was accomplished with minimal impact to the user community. Several methods of directory integration were tested, but in the end a political problem stopped the directory integration from actually taking place. It is hoped that these problems will be resolved soon so that directory synchronization can take place.

Web Based Directory Services Web based directory services were provided to the SED user community through implementation of the Microsoft Exchange server web mail interface. The primary concern in this implementation was to provide access to the SED email system and directory without compromising security. Data encryption was implemented using SSL through the Internet Information Server, and applied to the SED web mail pages. Today the SED web mail system is an integral part of the network infrastructure. Very few problems were encountered while implementing this system, and it is hoped that it will continue to provide the SED users will remote access to email and directory information for years to come.

Network Management Hub management is being handled Digital Equipment Corporation's (DEC) ClearVISN network management software, a graphical management utility. As DEC equipment is the primary equipment used for backbone transport, ClearVISN is able to handle management of almost all installed equipment.

The Network General Sniffer has proved to be an invaluable tool in monitoring both the Ethernet and FDDI network currently in place at SED. With a possibility of higher traffic speeds in the future, it may be necessary to purchase another Sniffer version capable of monitoring this faster traffic to add to the tool chest.

Another group is currently handling monitoring of Internet traffic at the campus level, and duplication of this ability is not necessary at the local level.

Operational Network Support The Support Center has processed over 2000 total help-desk requests during the period of performance of this D.O. This number is very significant when you consider the fact that the Support Center does not actively advertise its existence to the SED community, as well as the current staffing level. The staffing level is currently being increased to accommodate this increased support, as well as in preparation for the SED Annex which will soon be operational.

APPENDIX A: Equipment purchased

The following items were purchased on this Delivery Order:²

- Test Out! Training Guide for MS NT4 MCSE
- 20 Microsoft Exchange Client Access Licenses part # 381-00851
- Windows 98 CD (part # 730-00001) Full Installation
- Windows 98 Plus CD (part # 320-00123)
- Visio Professional CD 5.0
- Crimpmaster Frame and Dies for RJ-45 Crimp Tool
- Crimpmaster Replacement Dies for Crimpmaster
- Cisco IOS and Configuration Manuals
- Digital Pathworks for OpenVMS Documentation Package Manufacturer Part Number QA-A93AA-GZ
- Microsoft SQL Server 7.0 Manufacturer Part Number 228-00328
- Cyan Tektronix Color Sticks for Phaser 340 (016-1308-01)
- Magenta Tektronix Color Sticks for Phaser 340 (016-1309-01)
- Yellow Tektronix Color Sticks for Phaser 340 (016-1310-01)
- LN17 EP Toner Cartridges (LN17X-AA)
- Visio Enterprise Upgrade from Visio Pro (121345)
- Microsoft TechNet Academic Single Server License Unlimited User Educational (323-00258)
- Cisco Networking and Configuration Manuals plus "Mastering Access 97"
- TFTPServer32 Version 3

² Single quantity purchases were made unless otherwise indicated.